CLAIMS

1. A system for creating an individual, three-dimensional virtual tooth model representing a tooth found in a dentition assigned to a patient, comprising:

a memory storing at least one virtual three-dimensional model of a template object corresponding to a tooth, including a template tooth corresponding to said tooth;

a data processing system including a memory storing a virtual three-dimensional model of at least a part of the dentition;

wherein said data processing system further comprises software processing said virtual three-dimensional model of at least a part of the dentition and said virtual model of the template object and responsively deriving said individual, three-dimensional, virtual tooth model.

2. The system of claim 1, wherein said template object comprises one or more specific characteristics of a tooth selected from the group consisting of cusps, tooth width, occlusion characteristics, two-dimensional cross-section in an occlusal plane, roots and flatness.

3. The system of claim 1, wherein said template object comprises a surface formed of a mesh of polygon surfaces.

4. The system of claim 1, wherein said template object comprises a cloud of three-dimensional points.

5. The system of claim 1, wherein said virtual three-dimensional model of at least a part of the dentition comprises a surface formed of a mesh of polygon surfaces.

6. The system of claim 1, wherein said virtual three-dimensional model of at least a part of the dentition comprises a cloud of three-dimensional points.

7. The system of claim 1, wherein said individual, three-dimensional, virtual tooth model comprises a surface formed of a mesh of polygon surfaces.

8. The system of claim 1, wherein said individual, three-dimensional, virtual tooth model comprises a surface formed of a mesh of three-dimensional points.

9. The system of claim 1, wherein said software superimposes and orients said virtual template object with respect to said virtual three-dimensional model of at least a part of the dentition.

10. The system of claim 1, wherein said software determines specific areas of said virtual three-dimensional model of at least a part of the dentition that correspond to structural elements of said virtual template object.

11. The system of claim 1, wherein said individual three-dimensional virtual tooth model comprises, at least in part, surfaces derived from said virtual template object.

12. The system of claim 1, wherein said individual three-dimensional virtual tooth model comprises, at least in part, surfaces derived by said software from said virtual model of at least a part of said dentition.

13. The system of claim 1, wherein spatial coordinates for portions of said virtual tooth model, to which no corresponding areas could be determined from said virtual model of at least a part of the dentition, are derived by said software from spatial coordinates of corresponding portions of said virtual template object.

14. The system of claim 13, wherein said software derives said spatial coordinates from an interpolation from said template tooth.

15. The system of claim 1, wherein said system further comprises a user interface, and wherein said software displays said individual virtual tooth model on said user interface.

16. The system of claim 15, wherein said system includes software that permits a user to place a landmark on a virtual representation of said tooth of the patient via said user interface, said landmark used to align said virtual template object corresponding to a tooth with said virtual three-dimensional model of at least a part of the dentition.

17. The system of claim 16, wherein said user interface displays a superposition of said individual virtual tooth model and said virtual three-dimensional model of at least a part of the patient's dentition.

18. The system of claim 16, wherein said data processing system generates individual virtual tooth models for all of the teeth of a patient and displays said virtual tooth models on a user interface.

19. The system of claim 18, wherein said virtual tooth models are displayed on said user interface in a position relative to each other in three dimensions that substantially matches the current position of the teeth in the dentition of the patient.

20. The system of claim 1, wherein said software comprises:

1. a routine superimposing said virtual template object corresponding to a tooth on said virtual model of at least a part of the dentition;
2. a routine drawing vectors from said virtual template object to a surface of said virtual model of the dentition and storing a set of points where said vectors intersect said surface;
3. a routine forming a new surface comprised of said set of points; and
4. a routine filling missing parts of said surface, if any, from said template tooth.

21. The system of claim 20, wherein the software module executes routines 1., 2., 3., and 4. in an iterative fashion, with the surface after execution of step 3. or step 4. replacing the virtual model of the dentition at step 1. in successive iterations.

22. The system of claim 20, wherein said iterative execution of steps 1., 2., 3., and 4. terminates, the surface generated after the final iteration is displayed for the user as a

superposition of original data obtained from scanning and the surface created by said software at the end of step 3. or step 4. after the last iteration.

23. The system of claim 1, wherein said virtual model of the dentition comprises a plurality of three-dimensional surfaces as a result of the registration a plurality of point clouds representing three-dimensional frames with respect to each other.

24. The system of claim 1, wherein the system further comprises a hand-held scanner for scanning the dentition of said patient, wherein said virtual three-dimensional model of a part of the dentition is derived from said scanning.

25. An orthodontic workstation, comprising:

a memory storing virtual three-dimensional template teeth and a virtual three-dimensional model of the dentition of a patient;

a data processing system operating on said virtual template teeth and said virtual model of the dentition and responsively creating a set of individual, virtual, three-dimensional tooth models representing the teeth of the patient and storing said individual, virtual, three-dimensional tooth models in said memory.

26. The workstation of claim 25, further comprising a user interface displaying said virtual tooth models.

27. The workstation of claim 25, wherein said user interface displays a screen allowing a user to enter information to change the position of at least one of the virtual tooth models relative to other virtual tooth models in three dimensions.

28. The workstation of claim 25, wherein said user interface displays a screen allowing a user to enter information as to a desired archform, and wherein said workstation executes software moving said individual, virtual, three-dimensional tooth models to said desired archform and displays said individual, virtual, three-dimensional tooth models at said desired archform for a user.

29. The workstation of claim 25, wherein said user interface displays said virtual model of the dentition and permits a user to place landmarks on said displayed virtual model of the dentition.

30. An orthodontic workstation, comprising:

a memory comprising data storage regions storing a data representing virtual three-dimensional anatomical structures including an individual, three-dimensional virtual tooth model representing an individual tooth of a patient isolated from surrounding anatomical structures;

a user interface including a display for displaying said individual virtual tooth model;

interactive software for allowing a user to manipulate said virtual tooth model with respect to said surrounding anatomical structures.

31. The workstation of claim 30, wherein said individual virtual tooth model is generated from a scan of the dentition of a patient and a virtual three-dimensional template tooth.

32. The workstation of claim 30, wherein said individual, three-dimensional virtual tooth model further comprises a root for said tooth, said root derived from a virtual, three-dimensional template tooth root.

33. The workstation of claim 30, wherein said memory further comprises data storage regions storing a plurality of virtual, three-dimensional template orthodontic brackets.

34. The workstation of claim 33, wherein said workstation further comprises software for permitting a user to place one of said virtual, three-dimensional template orthodontic brackets onto the surface of said individual, virtual three-dimensional tooth model and display said placed template bracket on said individual, virtual three-dimensional tooth model.

35. The workstation of claim 30, wherein said memory stores data representing a library of virtual, three dimensional template teeth.

36. The workstation of claim 22, wherein said library is generated from the processing of scans of a plurality of patients.

37. The workstation of claim 33, wherein said memory stores a virtual, three-dimensional model of a template of an oral structure selected from the group of oral structures consisting of tooth roots, tooth crowns, gingival tissue, and bone.

38. An orthodontic workstation, comprising:

a memory storing a library of virtual orthodontic objects, said objects comprising virtual, three-dimensional orthodontic brackets;

a user interface; and

a processing system including software for displaying said orthodontic brackets on said user interface and providing a navigational tool for enabling a user of said workstation to independently move said virtual orthodontic brackets in three dimensions.

39. The workstation of claim 38, wherein said objects further comprise individual, virtual three-dimensional tooth objects and wherein said software enables said orthodontic brackets to be placed on said tooth objects.

40. The workstation of claim 38, wherein said objects further comprise virtual three-dimensional template teeth.

41. The workstation of claim 38, wherein said objects further comprise virtual three-dimensional template gingival tissue.

42. The workstation of claim 38, wherein said objects further comprise virtual three-dimensional template bone structures.

43. A method of separating a virtual tooth object from a virtual model of the dentition of a patient, comprising the steps of:

presenting on a user interface of a workstation a three-dimensional virtual model of the dentition;

providing a pair of virtual planes and a navigational tool for manipulating said pair of virtual planes with respect said three-dimensional virtual model;

placing said pair of virtual planes on opposite sides of a tooth in said virtual model of the dentition;

identifying on said user interface locations where said tooth intersects gingival tissue;

identifying spatial coordinates of said virtual model of the dentition where said tooth intersects said ginival tissue; and

forming said virtual tooth object from said portions of said tooth between said planes and the portion of said tooth separated from said gingival tissue.

44. The method of claim 43, further comprising the step of:

providing an erasing feature by which a user may delete from said virtual tooth object structures that do not correspond to said tooth.

45. The method of claim 43, wherein said virtual model of said dentition has gaps in data and wherein said gaps in data are derived from a template virtual three dimensional tooth object.

46. The method of claim 45, wherein said template virtual tooth object comprises a contralateral tooth.

47. In a method for making a crown for a tooth in which a crown is manufactured to fit to a prepared tooth, the improvement comprising:

scanning said prepared tooth and responsively creating virtual model of said prepared tooth;

storing in memory a virtual template crown for said tooth; and

providing a user interface and software wherein said software displays said virtual crown object and said virtual model of said prepared tooth and permits a user to adapt said virtual crown object to said virtual model of said prepared tooth.

48. A method for making a denture for a patient, comprising the steps of:

scanning the gums and associated anatomical structures of the patient;

constructing a virtual three-dimensional model of the gums and associated anatomical structures from said scanning;

displaying said virtual three-dimensional model on a user interface of a computer;

accessing with said computer a plurality of three-dimensional virtual template tooth objects;

orienting said three-dimensional template tooth objects with respect to each other to thereby provide a desired tooth position for said denture with the said of said computer;

combining said oriented three-dimensional virtual template teeth with said three-dimensional virtual model of the gums and associated anatomical structures with the aid of said computer; and

preparing said denture from the three-dimensional combination of said three-dimensional virtual template teeth with said three-dimensional virtual model of the gums and associated anatomical structures.

49. The method of claim 48 wherein said step of preparing comprises the step of preparing a physical model of said denture from said combination of said oriented three-dimensional virtual template teeth and said three-dimensional virtual model of the gums and associated anatomical structures;

preparing a mold from said physical model; and

casting said denture in said mold.

50. The method of claim 49, wherein said physical model comprises a sterelithograph model.